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The Alkaloids of Fumariaceous Plants. XXXIX. The Constitution of Capaurine

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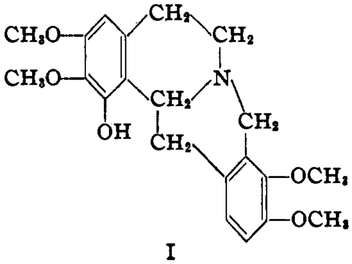
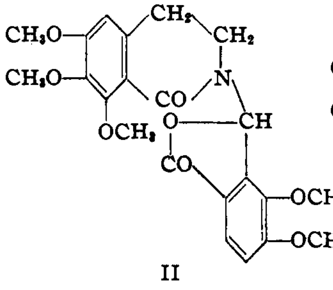
Capaurine and capauridine have been recorded as constituents of four plants, namely, *Corydalis aurea* Willd.,[3] *C. micrantha* (Engelm.) Gray,[4] *C. pallida* (Thunb.) Pers.,[5] and *C. montana* (Engelm.) Britton.[6] They are isomeric and the latter is in fact the *dl*-form of the former. The empirical formula, $C_{21}H_{25}O_5N$, on the basis of analogy with other *Fumariaceous* alkaloids, makes it highly probable that capaurine is a derivative of protoberberine. There are four methoxyl groups and one phenolic hydroxyl which is easily alkylated with diazomethane or with diazoethane. The fully methylated base on complete oxidation with permanganate yields a mixture of hemipinic and 3,4,5-trimethoxyphthalic acids. Since the phenolic base on oxidation yields only hemipinic acid, the formula (I) was used as a working hypothesis.



I



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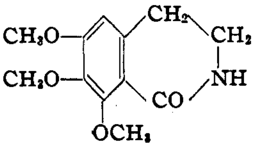

III

The chosen position of the hydroxyl is in analogy with that in narcotoline,[7] and this supposition was to a certain extent verified by the isolation of 3-ethoxy-4,5-dimethoxyphthalic acid by the oxidation of capaurine O-ethyl ether. There remained the possibility that the hydroxyl was present in the position para to the one shown, and indeed that the general nuclear structure did not conform to that shown. The latter moot point was to a certain extent resolved by the observation that iodine oxidation of capaurine and its methyl ether yielded quaternary iodides which on reduction were converted into the racemic bases identical with capauridine and its methyl ether respectively. Finally, the position of the hydroxyl group and the depicted nuclear structure were determined by mild oxidation of capauridine O-methyl ether under the conditions used with other protoberberine bases to yield the so-called corydaldines. Two products were obtained. The most readily isolated compound yielded analytical figures in agreement with $C_{22}H_{23}O_8N$ containing five methoxyl groups. It is regarded as possessing structure (II) and therefore is a close analog of berberal.[8] On hydrolysis with dilute sulfuric acid it yields ψ-opianic acid and the corydaldine, 6,7,8-trimethoxy-1-keto-1,2,3,4-tetrahydroisoquinoline (III), which is also obtainable from the mixture of mild oxidation products. It is therefore concluded that the complete structure of capaurine (and its *dl*-form, capauridine) is unambiguously represented by formula (I).

The identification of 3-ethoxy-4,5-dimethoxyphthalic acid necessitated the synthesis of an authentic specimen. The procedure of Späth[9] is regarded as somewhat cumbersome and a new synthesis has been achieved. β-2-Hydroxy-3,4-dimethoxy-benzoylpropionic acid was reduced to the corresponding butyric acid (Clemmensen), the latter ethylated and cyclized to 1-keto-5-ethoxy-6,7-dimethoxytetrahydronaphthalene, and finally the tetralone was oxidized to 3-ethoxy-4,5-dimethoxyphthalic acid. The anhydride melted at 108°[10] as recorded by Späth.[9] It was converted into the corresponding N-ethylimide and N-methylimide. The former was used to characterize the acid isolated from the oxidation of capaurine O-ethyl ether.

The corydaldine (III) does not appear to have been described hitherto. It was synthesized by two different routes and the synthetic compound proved to be identical with that obtained by the oxidation of capauridine O-methyl ether. In one procedure N-carbethoxy-β-3,4,5-trimethoxyphenylethylamine was cyclized with phosphoryl chloride. In the second procedure the azide of β-3,4,5-trimethoxyphenylpropionic acid was decomposed in dry benzene and the resulting isocyanate also cyclized with phosphoryl chloride, a procedure used by Mohunta and Ray[11] to prepare corydaldine. Although the yield by this latter method is not high, the simplicity and ease of manipulation are features that recommend it.

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(3) Manske, *Can. J. Research*, **9**, 436–42 (1933).

(4) Manske, *ibid.*, **17B**, 57–60 (1939).

(5) Manske, *ibid.*, **18B**, 80–83 (1940).

(6) Manske, *ibid.*, **20B**, 49–52 (1942).

(7) Wrede, *Arch. exp. Path. Pharm.*, **184**, 331 (1937).

(8) Perkin, *J. Chem. Soc.*, **57**, 1064 (1890).

(9) Späth, *Ber.*, **65**, 1778–1785 (1932).

(10) All melting points are corrected.

(11) Mohunta and Ray, *J. Chem. Soc.*, 1263 (1934).

Experimental

Racemization of Capaurine.—A suspension of capaurine (1.0 g.) in boiling methanol containing an excess of potassium acetate was treated with iodine until the color due to the latter was permanent. The mixture was evaporated to dryness *in vacuo* and the brown residue heated with zinc and hydrochloric acid until the quaternary iodide had dissolved to yield a colorless solution. The latter was filtered, cooled, basified with excess ammonia and extracted with a large volume of ether. The residue from the washed ether extract crystallized in contact with methanol and then melted at 206°. There was obtained 0.7 g. of base which when recrystallized from chloroform-methanol melted at 208° either alone or in admixture with a specimen of capauridine.

By a similar procedure capaurine O-methyl ether (m. p. 152°) was racemized to capauridine O-methyl ether (m. p. 142°) identical with a specimen obtained by the methylation of capauridine with diazomethane.

Oxidation of Capaurine to Hemipinic Acid.—A solution of capaurine (1.0 g.) in dilute hydrochloric acid was poured into an aqueous solution of sodium hydroxide and the mixture treated with powdered potassium permanganate at room temperature until the color of the reagent was permanent for one hour. An excess of sodium bisulfite was added and the acidified solution exhausted with ether. The residue from the ether extract was redissolved in dilute ammonia and treated with excess calcium chloride to remove the oxalic acid. The acidified solution was again exhausted with ether and the residue sublimed *in vacuo*. The hemipinic anhydride as thus obtained was converted into its N-ethylimide, the latter sublimed *in vacuo*, and recrystallized from ether-hexane. Either alone or in admixture with an authentic specimen it melted sharply at 91°.

Capaurine O-Ethyl Ether.—A solution of capaurine in ethanol was treated with an excess of diazoethane in ether. After the mixture had remained in the refrigerator overnight the evolution of nitrogen had ceased. The excess reagent and the solvents were distilled off, the residue dissolved in dilute hydrochloric acid, and the filtered solution basified with an excess of aqueous sodium hydroxide. The washed ethereal solution of the liberated base was dried over solid potassium hydroxide and the solution evaporated to a small volume. The base which then separated consisted of stout colorless prisms which when recrystallized once more from boiling ether melted sharply at 134°.

Anal. Calcd. for $C_{23}H_{29}O_5N$: N, 3.51. Found: N, 3.40, 3.55.

Capauridine O-Methyl Ether.—A suspension of 4.0 g. of capauridine in a mixture of chloroform (20 cc.) and methanol (80 cc.) was cooled and treated with an ethereal solution of 0.8 g. diazomethane. After twenty-four hours a like amount of diazomethane was added and the process repeated until a total of 4.2 g. had been added. The alkaloid had dissolved completely and an excess of reagent was then present. The solvents were distilled off, the residual oil dissolved in dilute hydrochloric acid, the filtered solution extracted with several portions of ether, basified with excess aqueous sodium hydroxide, and extracted again with a liberal volume of ether. The washed and dried solution (sodium sulfate) on evaporation yielded 4.0 g. of pale yellow residue which crystallized in contact with methanol-ether. The separated crystals were recrystallized from a large volume of boiling ether and then melted sharply at 142°.

Anal. Calcd. for $C_{22}H_{27}O_5N$: C, 68.57; H, 7.01; 5-OMe, 40.26. Found: C, 68.36, 68.70; H, 6.92, 7.09; OMe, 39.99, 39.96.

Oxidation of Capaurine O-Methyl Ether to Hemipinic and 3,4,5-Trimethoxyphthalic Acids.—An aqueous acid solution of capaurine O-methyl ether (2 g.) which had been rendered faintly alkaline by the addition of sodium bicarbonate was oxidized by the portionwise addition of potassium permanganate at room temperature until the color of the reagent was permanent for four hours. The mixture of acids was isolated, freed of oxalic acid, and converted into their N-ethylimides as in the foregoing example. The greater portion of the imide of hemipinic acid remained as a crystalline residue when the mixture was extracted with several successive portions of hexane. (It was purified by recrystallization from ether-hexane and authenticated by mixed melting point determination.) Systematic separation of the more soluble portions yielded impure 3,4,5-trimethoxy-N-ethyl-phthalimide (m. p. 80–85°) which was resublimed and then recrystallized twice from hot water. The colorless fine needles thus obtained melted sharply, either alone or in admixture with an authentic specimen, at 93°.

Oxidation of Capaurine O-Ethyl Ether to Hemipinic and 3-Ethoxy-4,5-dimethoxyphthalic Acids.—The oxidation of the O-ethyl ether was carried out in the manner described above for the corresponding O-methyl ether. The purification of the acids, and the separation of the N-ethylimides, followed the same course. The N-ethylhemipinimide was again characterized and the 3-ethoxy-4,5-dimethoxy-N-ethyl-phthalimide after two recrystallizations from water melted sharply at 76°, either alone or in admixture with a synthetic specimen.

Oxidation of Capauridine O-Methyl Ether to a Berberal Analog and to a Corydaldine.—A solution of the above ether (3.9 g.) in 100 cc. of water containing just sufficient hydrochloric acid to dissolve the base, was cooled to 10° and treated with an aqueous solution of sodium bicarbonate until the incipient turbidity just remained. Ice was added and a saturated aqueous solution of potassium permanganate (7.0 g.) added in one portion. After one hour the oxidizing agent had been consumed. The heated mixture was filtered, cooled, and extracted with seven successive portions of ether. The residue from the ether extract was extracted with several successive portions of boiling water (200 cc. in all) and the filtered and cooled solution again exhausted with ether. The residue from the ether extract in contact with ether containing a little methanol crystallized readily. The substance was recrystallized from methanol-ether and then melted at 192°. It is the compound represented by formula (II).

Anal. Calcd. for $C_{22}H_{23}O_8N$: C, 61.54; H, 5.74; N, 3.26; 5-OMe, 36.13. Found: C, 61.64, 61.67; H. 5.46, 5.39; N, 3.37, 3.41; OMe, 35.98, 35.98.

The aqueous solution from which ether had removed the above compound was extracted with several portions of chloroform. The residue from the chloroform extract was sublimed from a small tube *in vacuo* (210° (1 mm.)). The colorless sublimate which slowly crystallized was recrystallized twice from methanol-ether. It then consisted of pale yellow plates melting sharply at 138°. In admixture with a specimen of 6,7,8-trimethoxy-1-keto-1,2,3,4-tetrahydro-isoquinoline (m. p. 138°) prepared from N-carbethoxy-β-3,4,5-trimethoxyphenylethylamine it also melted at 138°. In admixture with a specimen of the same isoquinolone (m. p. 136–137°), prepared from the azide of β-3,4,5-trimethoxyphenylpropionic acid, it melted at 137–138°.

Hydrolysis of the Compound (II).—A solution of the above compound (0.15 g.) in 10% sulfuric acid (20 cc.) was heated on the steam-bath for eight hours. The cooled solution was extracted with ether and the acidic portion of the extract removed by shaking with aqueous sodium bicarbonate. The acidified solution was again extracted with ether and the residue from the latter sublimed *in vacuo*. There was obtained a colorless crystalline sublimate (wt. 25 mg.) which reduced ammoniacal silver nitrate and melted not sharply at 115–121° (Perkin[9] gives 121–122° as the melting point of ψ-opianic acid.) The acid was definitely characterized by oxidation (permanganate) to hemipinic acid and the latter converted into its N-ethylimide. The sublimed substance was recrystallized twice from hexane and then melted at 89°. In admixture with an authentic specimen of N-ethyl-hemipinimide (m. p. 91°) it melted at 90°.

The acid solution from which the ψ-opianic acid had been removed was treated with an excess of aqueous sodium carbonate and exhausted with chloroform. The residue from the extract was sublimed *in vacuo* and recrystallized from ether containing a trace of methanol. It then melted at 136° and in admixture with the isoquinolone (m. p. 138°) obtained from the oxidation of capauridine O-methyl ether it melted at 137°.

β-(2-Hydroxy-3,4-dimethoxybenzoyl)-propionic Acid.—Following the procedure of Mitter and De,[12] a solution of 1,2,3-trimethoxybenzene (50 g.), succinic anhydride (30 g.) and tetrachloroethane (120 cc.) maintained at −15° was treated with finely ground aluminum chloride (90 g.) during the course of three hours and then allowed to remain at room temperature for sixty hours. The mixture was decomposed with water and the volatile portion distilled in a current of steam. The solid obtained from the cooled mixture was recrystallized three times from hot water, yielding 24 g. of the desired material melting at 148°.

In a second experiment in which one-half of the tetrachloroethane was replaced by an equal volume of nitrobenzene, the solvents were not distilled with steam until the organic layer had been separated and washed with water. There was obtained a mixture of the above acid and the undemethylated compound. The dried mixture was esterified with absolute ethanol and sulfuric acid and the mixture of esters in ether extracted with several successive portions of chilled aqueous sodium hydroxide. The alkali insoluble ester was distilled *in vacuo* (b. p. 197–198° (1 mm.)) and recrystallized from benzene–hexane—yield 5.5 g. The dense colorless prisms of ethyl β-(2,3,4-trimethoxybenzoyl)-propionate thus obtained melted at 57° and failed to give a color with alcoholic ferric chloride.

Anal. Calcd. for $C_{15}H_{20}O_6$: C, 60.80; H, 6.80. Found: C, 60.93, 60.72; H, 6.96, 6.78.

Hydrolysis with aqueous alkali yielded β-(2,3,4-trimethoxybenzoyl)-propionic acid, which when recrystallized from hot water was obtained in long needles melting at 89°.

Anal. Calcd. for $C_{13}H_{16}O_6$: C, 58.20; H, 6.01. Found: C, 58.24, 58.35; H, 6.20, 6.22.

5-Ethoxy-6,7-dimethoxy-1-keto-tetrahydronaphthalene.—The reduction of β-(2-hydroxy-3,4-dimethoxybenzoyl)-propionic acid to the corresponding butyric acid and the ring closure of the latter to the hydroxy-tetralone followed the procedure of Mitter and De. The yields were, respectively, 88 and 76% of purified products. The latter (12 g.) was dissolved in a mixture of 50% aqueous potassium hydroxide (35 cc.) and ethanol (10 cc.) and the heated solution treated with diethyl sulfate (20 g.), the reaction being carried out in an atmosphere of nitrogen. After boiling for one hour the cooled mixture was exhausted with ether and the residue from the washed extract distilled *in vacuo*. There was obtained 10 g. of a viscous liquid boiling at 211–212° (18 mm.). It could not be induced to crystallize and was characterized as the oxime. For this purpose it was treated with equal weights of hydroxylamine and sodium acetate in a small volume of water containing a little methanol and the mixture heated on the steam-bath. On cooling, the separated oil crystallized readily. It was recrystallized three times from aqueous methanol and then consisted of rosets of colorless needles melting at 104°.

Anal. Calcd. for $C_{14}H_{19}O_4N$: N, 5.28. Found: N, 5.16, 5.35.

3-Ethoxy-4,5-dimethoxyphthalic Anhydride.—A suspension of 5-ethoxy-6,7-dimethoxy-1-keto-tetrahydronaphthalene (10 g.) in water (50 cc.) was treated with small portions of powdered potassium permanganate until the color of the reagent was permanent for four hours at room temperature. The oil gradually emulsified and disappeared in about three days. Water was added from time to time to permit proper stirring. The mixture was finally heated on a steam-bath and treated with calcium chloride and ammonium chloride to precipitate the oxalic acid. The colorless filtrate from the above mixture was acidified with hydrochloric acid and thoroughly extracted with ether. The residue from the extract was sublimed *in vacuo* (150–170° (1–2 mm.)), resublimed (150–160° (1 mm.)), and recrystallized from dry ether. The anhydride as thus obtained consisted of long colorless needles melting sharply at 108°.[10]

Anal. Calcd. for $C_{12}H_{12}O_6$: C, 57.14; H, 4.80. Found: C, 57.36; H, 5.00.

The N-ethylimide was sublimed *in vacuo* (137–142° (1 mm.)), recrystallized twice from ether–hexane, and once from hot water. It consisted of fine colorless needles melting sharply at 76°.

Anal. Calcd. for $C_{14}H_{17}O_5N$: N, 5.01. Found: N, 4.96, 4.98.

The N-methylimide was sublimed *in vacuo* and after recrystallization from ether or from water consisted of stout needles melting at 92°.

Anal. Calcd. for $C_{13}H_{15}O_5N$: C, 58.86; H, 5.70; N, 5.28. Found: C, 58.96, 58.70; H, 6.05, 6.06; N, 5.14, 5.20.

6,7,8 - Trimethoxy - 1 - keto - 1,2,3,4 - tetrahydro - isoquinoline.—β-(3,4,5-Trimethoxyphenyl)-propionic acid[13] was converted into its methyl ester in 86% yield by heating with methanol and sulfuric acid. It was obtained as a colorless viscous oil; b. p. 153–155° (1 mm.). The corresponding hydrazide was obtained by heating the methyl ester (9.5 g.) with hydrazine hydrate (4.0 g.) on the steam-bath for six hours. On cooling the mixture solidified and it was completely soluble in cold water from which solution exhaustive ether extraction failed to remove more than a trace. (In an experiment in which the mixture of ester and hydrazine was heated to 125° there was obtained a small yield of the disubstituted hydrazide, $C_{11}H_{15}O_3CO$-$NHNHCOC_{11}H_{15}O_3$, which separated in colorless crystals when the mixture was diluted with water. When recrystallized from much hot water it consisted of long needles melting at 168°.

Anal. Calcd. for $C_{24}H_{32}O_8N_2$: N, 5.88. Found: N, 6.00, 6.02.

The aqueous solution of the hydrazide was treated with ice, acidified with an excess of hydrochloric acid, and a solution of sodium nitrite added until a slight excess was present. The separated oily azide was extracted with several portions of benzene and the washed extract evaporated *in vacuo* at room temperature until all of the water had been removed. This dry benzene solution of the azide was gently warmed until most of the azide had decomposed and then gently boiled for a short while. Complete removal of the benzene *in vacuo* yielded 8.2 g. of the isocyanate as a pale brown oil.

A solution of the isocyanate (4.5 g.) in dry xylene (20 cc.) was treated with phosphorus pentoxide (0.3 g.) and phosphorus oxychloride (10 g.) and the mixture boiled under reflux for two hours. Some of the solvent was then removed *in vacuo*, water added to the residue and the remainder of the organic solvent distilled off. The cooled and filtered solution was extracted with ether until the extract was colorless. The aqueous solution was next treated with an excess of aqueous sodium carbonate and extracted with several portions of chloroform. The dried extract was freed of solvent and the residue sublimed *in vacuo*. The first fraction (b. p. up to 180° (1 mm.)) consisted of a small amount of basic oil, probably β-(3,4,5-trimethoxyphenyl)-ethylamine. The main fraction was collected at 210–220° (1 mm.). It was dissolved in a small volume of methanol and treated with an equal volume of ether. The sparingly soluble substance which then separated was filtered off (see below) and the filtrate evaporated to a thin sirup. The warm residue was treated with much dry ether and the boiling clear supernatant solution decanted from a small amount of insoluble resin. Partial evaporation of the clear solution and inoculation with a crystal of 6,7,8-trimethoxy-1-keto-1,2,3,4-tetrahydro-isoquinoline, obtained from the degradation of capaurine methyl ether, induced immediate crystallization. After two further recrystallizations from

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[12] Mitter and De, *J. Indian Chem. Soc.*, **16**, 35–42 (1939).

[13] Slotta and Heller, *Ber.*, **63**, 3029–3044 (1930).

ether containing a trace of methanol the *quinolone* was obtained in colorless needles melting at 136–137°. In admixture with a specimen obtained from the alkaloid it melted at 137–138°; yield, 0.85 g.

8 - Hydroxy - 6,7 - dimethoxy - 1 - keto - 1,2,3,4-tetrahydro-isoquinoline.—The less soluble by-product obtained during the synthesis of the corresponding trimethoxy derivative (above) was recrystallized twice from methanol and then consisted of colorless elongated plates melting sharply at 181°.

Anal. Calcd. for $C_{11}H_{13}O_4N$: C, 59.19; H, 5.87; N, 6.27; 2 OCH_3, 27.79. Found: C, 59.10; H, 6.24; N, 6.26; OCH_3, 27.79.

This hydroxy-isoquinolone is obviously formed by the loss of one methoxyl group from the trimethoxy compound. That the free hydroxyl is in the 8-position was probable *a priori*, and was confirmed but not entirely proved by the following observations. The compound gives a blue color with alcoholic ferric chloride and was not ethylated, even partially, by treatment with diazoethane in ether–ethanol. Furthermore, it was obtained by partial demethylation of the trimethyl ether. For this purpose the latter (0.3 g.) was boiled under reflux for three hours with concentrated hydrochloric acid (20 cc.). The hydrochloric acid was removed under reduced pressure and the residue dissolved in a small volume of methanol. The crystalline material which then separated (0.2 g.), when recrystallized again from methanol, melted at 180–181°, either alone or in admixture with the substance as obtained above.

N - Carbethoxy - β - (3,4,5 - trimethoxyphenyl) - ethylamine.—This urethan was prepared in two ways. In one procedure β-(3,4,5-trimethoxyphenyl)-ethylamine[13] (5.1 g.) was dissolved in water (10 cc.) and the solution treated dropwise with ethyl chloroformate (3.5 g.) and maintained alkaline by the frequent addition of aqueous potassium hydroxide until the addition of further alkali ceased to produce a turbidity in the aqueous phase. The urethan was extracted with ether, washed with alkali, and the ether evaporated. The residual oil crystallized readily. It was recrystallized from benzene–hexane containing a trace of ether, and then consisted of stout colorless prisms melting at 68°. The yield was 6.4 g.

Anal. Calcd. for $C_{14}H_{21}O_5N$: N, 4.94. Found: N, 5.15, 4.94.

In the second procedure β-(3,4,5-trimethoxyphenyl) isocyanate (3.7 g.) was heated for several hours with absolute ethanol (10 g.), the solution evaporated, the residue dissolved in ether, the solution washed with water, and the residue from the ethereal solution distilled *in vacuo*. The fraction boiling at 170–180° (1 mm.) solidified completely on seeding with the above urethan. When recrystallized from ether–hexane it melted at 68° either alone or in admixture with a specimen obtained from the amine; yield 2.1 g.

6,7,8 - Trimethoxy - 1 - keto - 1,2,3,4 - tetrahydro - isoquinoline.—A solution of the urethan (see above) (2.5 g.) in xylene (2.0 cc.) containing phosphorus pentoxide (0.3 g.) and phosphorus oxychloride (5.0 g.) was boiled under reflux for one and a half hours. The solvent and excess reagents were then removed *in vacuo* on the steam-bath and water (50 cc.) was added to the residue. The remaining xylene was boiled out and the somewhat diluted solution filtered to remove neutral oil. The filtrate was exhausted with ether, basified with excess sodium carbonate solution, and extracted with chloroform. The residue from the dried chloroform extract was sublimed *in vacuo*. A slight forerun (b. p. 180° (1 mm.)) was discarded. The main fraction (b. p. 210–220° (1 mm.)) weighed 0.2 g. When recrystallized from ether it was obtained in brilliant hexagonal plates melting sharply at 138° either alone or in admixture with the isoquinolone obtained from the alkaloid.

Anal. Calcd. for $C_{12}H_{15}O_4N$: C, 60.75; H, 6.37; N, 5.90; 3 OCH_3, 39.21. Found: C, 61.00; H, 6.47; N, 6.01; OCH_3, 38.27, 38.04.

A small amount of this isoquinolone was oxidized in aqueous solution by treatment with an excess of permanganate in the cold. The acid was isolated in the usual way, converted into its ethyl imide, and the latter sublimed *in vacuo* (160–170° (1 mm.)). After two recrystallizations from hexane, the 3,4,5-trimethoxy-N-ethylphthalimide was obtained in colorless fine needles melting at 90–91°. In admixture with an authentic specimen it melted at 91–92°.

3,4,5-Trimethoxy-N-ethyl-phthalimide.—This compound does not appear to have been described. It was prepared by treating 3,4,5-trimethoxyphthalic acid or the anhydride with an excess of aqueous ethylamine, evaporating to dryness, heating to *ca.* 210° at the vacuum of a water pump and then subliming at 160–170° (1 mm.). The imide is very soluble in methanol or in ether and was recrystallized from ether–hexane. It may also be recrystallized from boiling water from which it separates in fine fragile needles. The purified substance melts at 93°.

Anal. Calcd. for $C_{13}H_{15}O_5N$: N, 5.28. Found: N, 5.26, 5.11.

The N-methyl-imide was similarly prepared. It is less soluble in methanol from which it was recrystallized. The long needles thus obtained melted at 127°.

Anal. Calcd. for $C_{12}H_{13}O_5N$: N, 5.54. Found: N, 5.49, 5.43.

Summary

1. The alkaloid capauridine is the racemic form of capaurine.

2. The constitution of these bases has been determined. They are the first known examples of the protoberberine alkaloids with five alkoxy- (or hydroxy-) groups in the molecule.

3. A number of degradation products of the alkaloids have been synthesized.

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